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Hayes

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(54) **PHOTOTHERAPY LIGHTS**

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(52) **U.S. Cl.**

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(58) **Field of Classification Search**

CPC **A61N 5/062**; **A61N 5/0616**

USPC **607/88-94**
See application file for complete search history.

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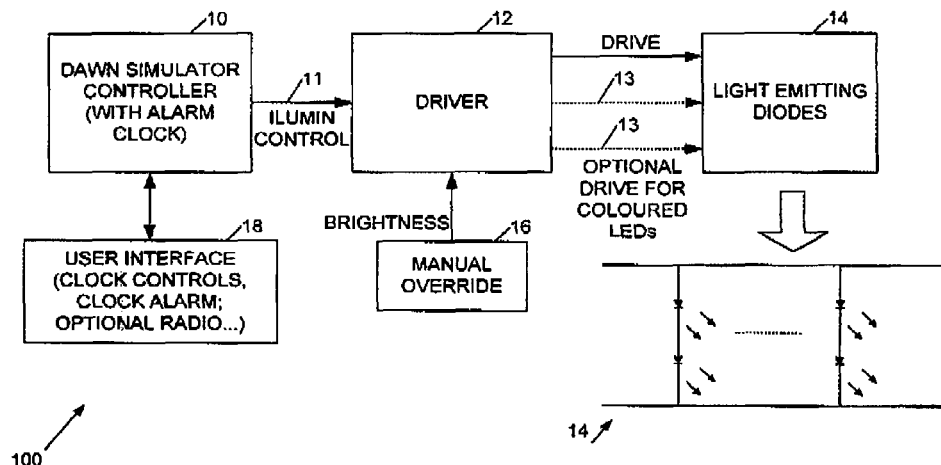
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(57)

ABSTRACT

This invention relates to phototherapy lights, in particular for a combination of Bright Light Therapy and Dawn Simulation. A phototherapy light source having two operational modes, a first dawn simulator mode; and a second, bright light therapy mode; the light comprising a controller coupled to a light source; and wherein, in said first mode said light source is controlled to provide variable illumination with a minimum light intensity of less than 1 lux at 50 centimeters, and in said second mode said light source is controlled to provide illumination with a light intensity of at least 1000 lux at 50 centimeters.

9 Claims, 2 Drawing Sheets



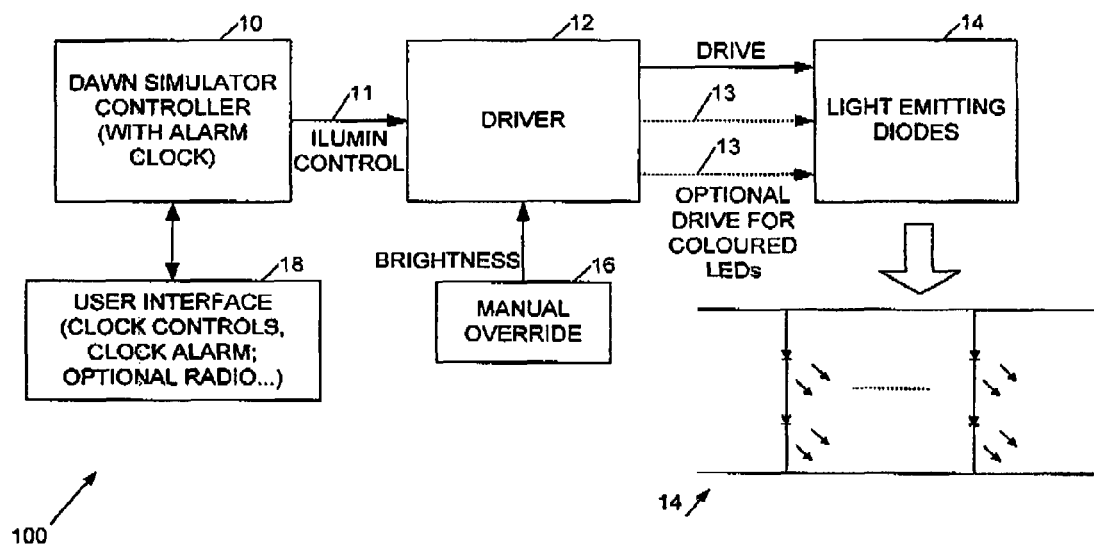


Figure 1

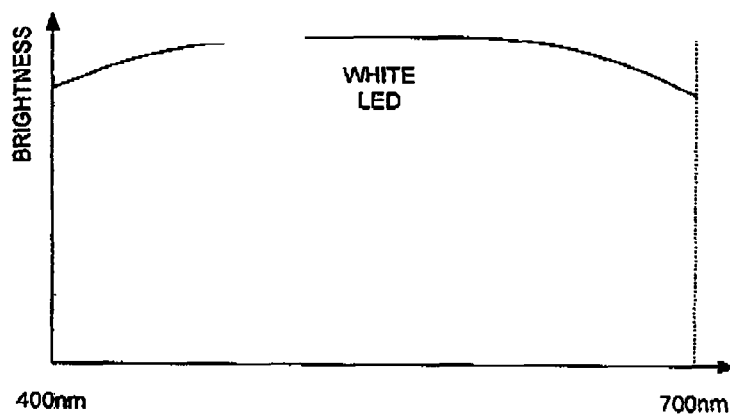


Figure 2a

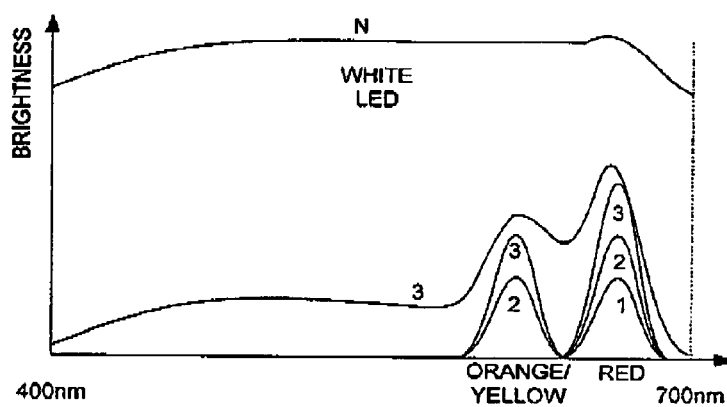


Figure 2b

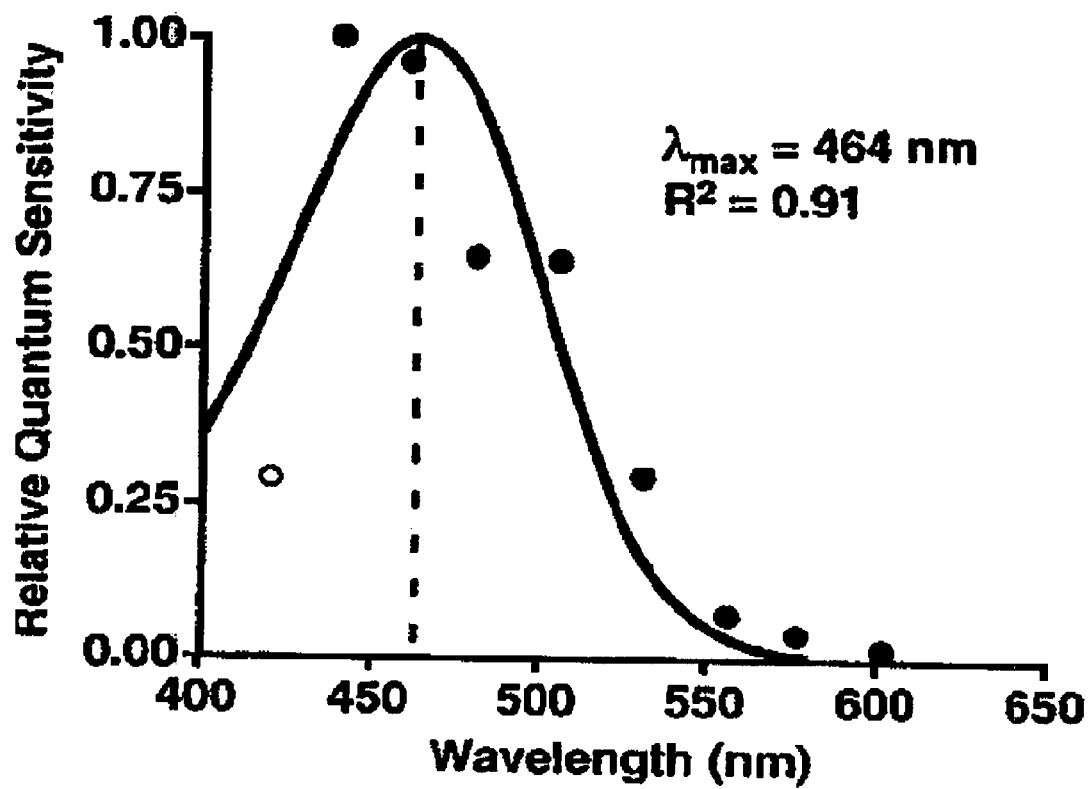


Figure 3

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PHOTOTHERAPY LIGHTS

RELATED APPLICATIONS

The present application claims priority from 5
GB0600478.2 filed 11 Jan. 2006 of the same title.

TECHNICAL FIELD

This invention relates to phototherapy lights, in particular 10
for a combination of Bright Light Therapy and Dawn Simulation.

BACKGROUND

Two fundamental techniques in phototherapy for chrono-
biological purposes are Bright Light Therapy and Dawn
Simulation. These can be used for the symptomatic relief of
inter alia, seasonal affective disorder (SAD), sleep pattern
disorders and the like. Dawn Simulator alarm clocks mimic 20
a natural sunrise in the morning and may also mimic a
natural sunset. This wakes the user gently and also assists the
user to fall asleep at night. We have previously described
some improved Dawn Simulators in UK Patent Application
Numbers 0501079.8 and 0501076.4, both filed on 19 Jan. 25
2005. Bright Light Therapy devices aim to simulate a natural
level of sunlight such as might be experienced on a Spring
morning on a clear day, and thus generally provide an output
of at least 1000 lux, often closer to 10,000 lux at a typical
distance from the user of around 0.5 meter.

There is, however, a continuing need for improved pho-
totherapy lights.

SUMMARY

According to the present invention there is therefore
provided a phototherapy light source having two operational
modes, a first dawn simulator mode; and a second, bright
light therapy mode; the light comprising a controller coupled
to a light source; and wherein, in said first mode said light
source is controlled to provide variable illumination with a
minimum light intensity of less than 1 lux at 50 centimeters,
and in said second mode said light source is controlled to
provide illumination with a light intensity of at least 1000
lux at 50 centimeters.

Preferably the light source comprises a plurality of light
emitting diodes (LEDs) to provide the illumination in both
the first, Dawn Simulator mode and the second, Bright Light
Therapy mode. Thus high output LEDs may be employed
for the bright light and progressively dimmed and/or 50
switched off in the Dawn Simulator (sunrise/sunset) mode.
Alternatively LEDs may be used to provide the lowest light
output levels, for example at the onset of dawn simulation,
and fluorescent or other discharge sources may be employed
for the Bright Light Therapy mode. Such discharge sources
may include cold cathode discharge sources and/or external
electrode fluorescent lamps (EEFL). However LEDs provide
a significant advantage in that a single type of lighting
technology may be employed for both the very low light
intensities used for dawn simulation, and the very high light
intensities used for Bright Light Therapy.

In some preferred embodiments the photo therapy light is
configured to change a colour of the illumination in the dawn
simulator mode so that the illumination is redder at low
levels and becomes progressively “whiter” as the illumina- 65
tion level increases. This aims to provide a more natural
simulation of dawn (and/or dusk) and hence provide a

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greater circadian effect. This may be achieved by employing
a light source comprising LEDs of at least two different
colours (here a “white” LED is considered as a “colour”), a
first colour, and a second colour redder than the first. The
phototherapy light may then incorporate a controller con-
figured to control a relative brightness of these different
coloured LEDs to alter the colour of the illumination in the
dawn simulator mode.

In some preferred embodiments a ratio of the Bright Light
Therapy light intensity to the minimum light intensity is at
least 1000: 1, more preferably 5000:1 or 10000:1. Thus in
embodiments the minimum light intensity may be less than
0.1 lux, and the Bright Light Therapy light intensity greater
than 1200 lux, 2500 lux or 5000 lux at a typical user distance
of around 50 centimeters. 15

In a related embodiment the invention provides a photo-
therapy light configured to provide at least two levels of
illumination, a first level of illumination and a second, lower
level of illumination, and wherein said illumination at said
second, lower level is redder than said illumination at said
first level. 20

Where the phototherapy light comprises a Bright Light
Therapy light. This is preferably dimmable to a substantially
off condition.

The invention further provides a combined Bright Light
Therapy device and Dawn Simulator comprising a light
source controllable over a brightness range of at least
1000:1. 25

The invention still further provides a combined Bright
Light Therapy device and Dawn Simulator in which the light
source comprises a plurality of light emitting diodes. 30

In embodiments a phototherapy light as described above
has at least one mode in which substantially no light output
is provided in a wavelength range below 560 nm (which
approximately corresponds to a green/yellow colour). 35

In a still further aspect the invention provides a photo-
therapy light having at least one mode in which the light
output is sufficient for Bright Light Therapy, for example for
treating SAD, the phototherapy light also being adjustable in
colour, in particular to provide room or other lighting which
has substantially no circadian effect. 40

The invention further provides a method of using a
phototherapy light as described above to treat seasonal
affective disorder, in particular by operating the light in both
a Dawn Simulator mode and a Bright Light Therapy mode. 45

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the invention will now be
further described by way of example, with reference to the
accompany figures in which:

FIG. 1 shows a block diagram of an embodiment of the
invention;

FIGS. 2a and 2b show example spectral outputs of the
device of FIG. 1; and 55

FIG. 3 shows a human melatonin suppression response.

DETAILED DESCRIPTION

Referring first to FIG. 1, an example combined Dawn
Simulator and Bright Light Therapy apparatus 100 com-
prises a Dawn Simulator controller 10 typically comprising
an alarm clock in which prior to the alarm time an illumina-
tion control output controls illumination to gradually
ramp to a maximum level (at which time, for example, a
radio might also be switched on). The illumination control
signal is provided to a driver 12, for example employing 65

pulse width modulation, which provides a drive output to a plurality of light emitting diodes responsive to the illumination control signal **11**.

The LEDs are both serial and parallel connected, as shown in the inset to the figure. Optionally driver **12** may provide a plurality of drive outputs, in particular colour drive outputs **13** for changing an illumination colour of the phototherapy light, as described further below.

In one embodiment primarily white LEDs are employed with a typical spectrum as shown in FIG. 2a. Examples of suitable LEDs are the Nichia NSPW500BS (around 25 of these may be used to give a suitable Bright Light Therapy output) and/or LEDs in the Lumiled Luxeon range (5 or more of these may be employed to provide sufficient light output for Bright Light Therapy).

Referring again to FIG. 1, the apparatus also includes a manual override **16** for manual control of the brightness of the LEDs **14**, and a user interface **18** to provide controls for the Dawn Simulator, for example, clock, alarm and radio controls.

Referring now to FIG. 2b, the LEDs **14** may include one or more coloured LEDs, for example a set of one or more high output red LEDs and, optionally, a further set of one or more high output orange/yellow LEDs. These are controlled by driver **12** in conjunction with the white LEDs so that at low light levels substantially only the red LEDs are on, the orange/yellow and white LEDs being progressively turned on as the overall desired light output increases. This is indicated schematically in FIG. 2b by the labels, **1**, **2**, **3** . . . **N**, which indicate progressively increasing overall light output levels from the apparatus **100**.

Recent research in the field of Bright Light Therapy has indicated that certain parts of the visible spectrum, centred around approximately 470 nm —deep blue, have a greater circadian effect than other parts of the visible spectrum, in particular yellow/orange/red, above 560 nm. A possible mechanism for this response is illustrated in FIG. 3, which shows the results of an experiment indicating levels of melatonin suppression under different illumination wavelengths. Advantageously, therefore, the colour of the phototherapy light is varied during the dawn simulation process. This may be achieved, as indicated above, by using LEDs of different colours, selectively powering these LEDs so that the combined output progressively varies from dull red at the onset of the dawn simulation towards a colour more typical of daylight sunshine. Alternatively LEDs which are able to change colour (RGB-LEDs) may be employed.

In embodiments the Bright Light Therapy device may have a colour temperature greater than 5000K to provide a “cool” light source.

No doubt many other effective alternatives will occur to the skilled person. It will be understood that the invention is not limited to the described embodiments and encompasses modifications apparent to those skilled in the art lying within the spirit and scope of the claims appended hereto.

The invention claimed is:

1. A phototherapy light source having two operational modes,

a first dawn simulator mode; and
a second, bright light therapy mode;
the light comprising:

a light source comprising a plurality of light emitting diodes of different colours, said plurality of light emitting diodes being arranged to progressively vary an emitted spectrum of light from a first spectrum to a second spectrum, and

a controller coupled to a light source; and

wherein, in said first mode said light source is controlled to provide variable illumination with a minimum light intensity of less than 1 lux at 50 centimeters, and in said second mode said light source is controlled to provide illumination with a light intensity of at least 1000 lux at 50 centimeters,

said first spectrum has dull red light spectrum, and
said second spectrum has a colour of typical daylight sunshine and has greater overall intensity than the first spectrum, and wherein

said phototherapy light source is arranged to provide in said first dawn simulator mode an illumination mode in which light from said light emitting diodes has substantially no light output below 560 nm,

the phototherapy light configured to change a colour of said illumination in said dawn simulator mode such that the said illumination is redder at a lower illumination level than at a higher illumination level.

2. A phototherapy light as claimed in claim **1** wherein said light source comprises LEDs of at least two different colours, a first colour and a second colour redder than said first colour and wherein said controller is configured to control a relative brightness of said different coloured LEDs to alter the colour of said illumination in said variable illumination dawn simulator mode.

3. A phototherapy light as claimed in claim **1** wherein said light source comprises a plurality of light emitting diodes (LEDs) to provide said illumination in said bright light therapy mode, dimmable to provide said variable illumination.

4. A phototherapy light as claimed in claim **1** wherein said light source comprises at least one LED and at least one discharge light source; and wherein said controller is configured to use said at least one LED for said first dawn simulator mode and said discharge light source for said bright light therapy mode.

5. A phototherapy light as claimed in claim **1** wherein a ratio of said bright light therapy light intensity to said minimum light intensity is at least 1000:1.

6. A phototherapy light, said phototherapy light comprising a plurality of light emitting diodes of different colours, said light emitting diodes configured to provide at least two levels of illumination, a first level of illumination and a second, lower level of illumination with a light intensity of less than 1 lux at 50 centimeters, and wherein said illumination of said second, lower level is redder than said illumination at said first level, said plurality of light emitting diodes being arranged to progressively vary an emitted spectrum of light from a first spectrum having said second illumination level to a second spectrum having said first illumination level, wherein said first spectrum is a dull red light spectrum, and said second spectrum has a colour of typical daylight sunshine and has greater overall intensity than the first spectrum, and wherein said progressive variation of said phototherapy light has an illumination mode in which light from said light emitting diodes has substantially no light output below 560 nm, the phototherapy light configured to change a colour of said illumination in a dawn simulator mode such that the said illumination is redder at a lower illumination level than at a higher illumination level.

7. A phototherapy light as claimed in claim **6** wherein said phototherapy light is a dawn simulator configured to progressively vary said illumination from said second lower level to said first level.

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8. A phototherapy light as claimed in claim 6 wherein said phototherapy light is a bright light therapy light and wherein said first level of illumination is at least 1000 lux at 50 centimeters.

9. A phototherapy light as claimed in claim 6 comprising 5
a controller and light source including LEDs of at least two
different colours, a first colour and a second colour redder
than said first colour, and wherein said controller is config-
ured to control a relative brightness of said different
coloured LEDs for said first and second illumination levels. 10

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